

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings of claims in the application:

LISTING OF CLAIMS:

Claims 1-26 (cancelled)

27. (new) A functionalized carbon nanotube, the surface of which carries covalently bound reactive and/or activable functional groups which are homogeneously distributed on said surface, said functionalized carbon nanotube being substantially intact and soluble in organic and/or aqueous solvents.

28. (new) A functionalized carbon nanotube according to claim 27, wherein said carbon nanotube is a single-walled (SWNT) or a multi-walled carbon nanotube (MWNT).

29. (new) A functionalized carbon nanotube according to claim 28, wherein the organic solvents are selected from a group comprising dimethylformamide, dichloromethane, chloroform, acetonitrile, dimethylsulfoxide, methanol, ethanol, toluene, isopropanol, 1,2-dichloroethane, N-methylpyrrolidone, tetrahydrofuran.

30. (new) A functionalized carbon nanotube according to claim 29, of following general formula: $[C_n]-X_m$

wherein:

C_n are surface carbons of a substantially cylindrical carbon nanotube of substantially constant diameter, said diameter being from about 0.5 to about 50 nm, in

particular from about 0.5 to 5 nm for SWNTs and from about 20 to about 50 nm for MWNTs,

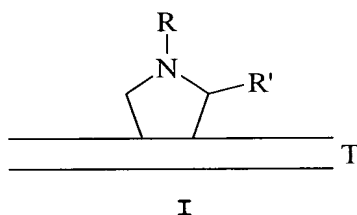
X is a functional group,

n is an integer from about $3 \cdot 10^3$ to about $3 \cdot 10^6$,

m is an integer from about $0.001n$ to about $0.1n$,

there are from about $2 \cdot 10^{-11}$ moles to about $2 \cdot 10^{-9}$ moles of X functional groups per cm^2 of carbon nanotube surface.

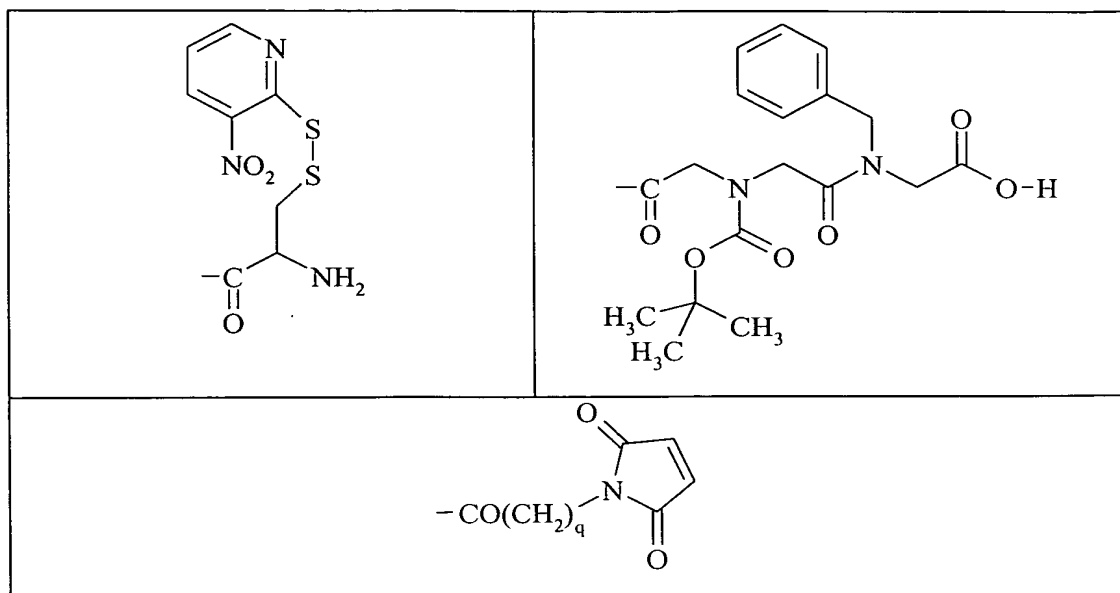
31. (new) A functionalized carbon nanotube according to claim 30, wherein X is a pyrrolidine ring, of the following general formula (I):



wherein T represents a carbon nanotube, and independently from each other R and R' represent -H or a group of formula -M-Y-(Z)_a-(P)_b, wherein independently from each other a and b represent 0 or 1, provided R and R' cannot simultaneously represent H, and:

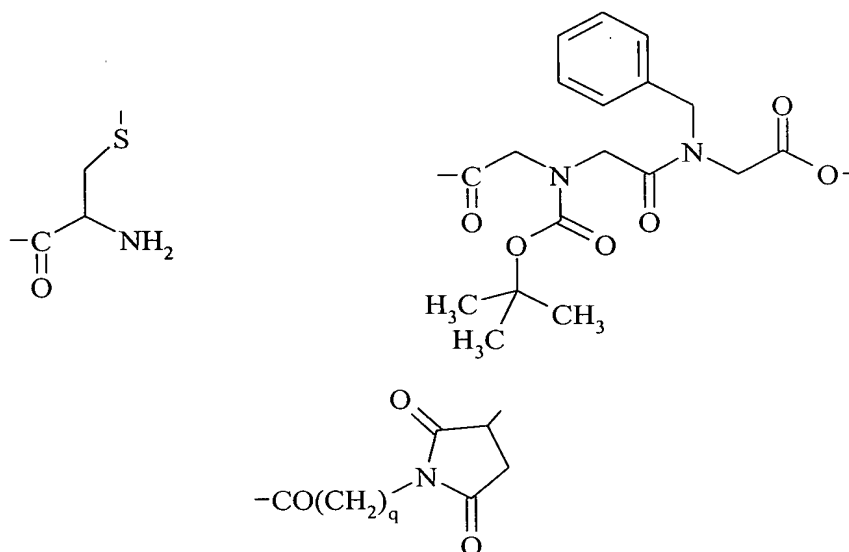
- M is a spacer group from about 1 to about 100 atoms, such as a group selected from the list comprising -(CH₂)_r- or -(CH₂-CH₂-O)_r-CH₂-CH₂-, wherein r is an integer from 1 to 20;
- Y is a reactive group when a=b=0, such as a group selected from the list comprising -OH, -NH₂, -COOH, -SH, -CHO, a ketone such as -COCH₃, an azide or a halide; or derived from a reactive group, when a or b is different from 0, such as a group selected from the list comprising -O-, -NH-, -COO-, -S-, -CH=, -CH₂-, -CC_kH_{2k+1}=, wherein k is an integer from 1 to 10, in particular -CCH₃=, or -CHC_kH_{2k+1}-, wherein k is an integer from 1 to 10, in particular -CHCH₃-;

- Z is a linker group, liable to be linked to a P group, and if need be to release said P group, such as a group of one of the following formulae when a=1 and b=0:



wherein q is an integer from 1 to 10;

or of one of the corresponding following formulae when a=1 and b=1:

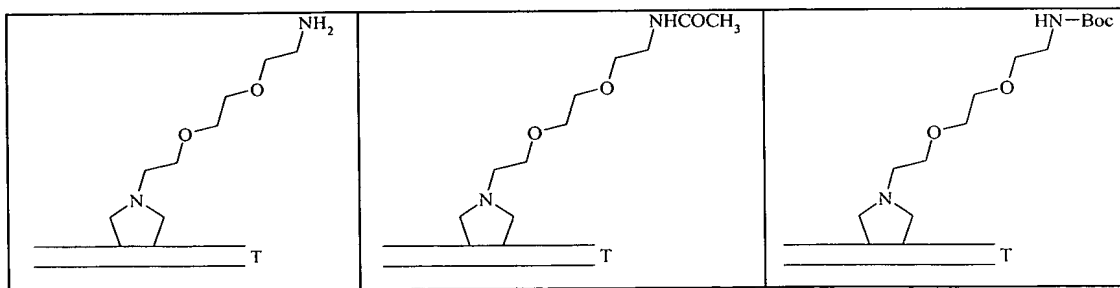


wherein q is an integer from 1 to 10;

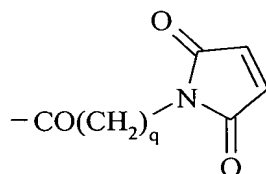
- P is an effective group allowing spectroscopic detection of said functionalized carbon nanotube, such as a fluorophore, such as FITC, or an active molecule, liable to induce a biological effect, such as an amino acid, a peptide, a pseudopeptide, a protein, such as an enzyme or an antibody, a nucleic acid, a carbohydrate, or a drug.

if appropriate at least one of Y, Z, or P groups, can be substituted by a capping group, such as $\text{CH}_3\text{CO}-$ (acetyl), methyl, or ethyl, or a protecting group such as methyl, ethyl, benzyl, *tert*-butyl, trityl, 3-nitro-2-pyridylsulfenyl, *tert*-butoxycarbonyl (Boc), fluorenylmethoxycarbonyl (Fmoc), benzylcarbonyl, trimethylsilylethoxycarbonyl, phthalimide, dimethylacetal, diethylacetal or, 1,3-dioxolane.

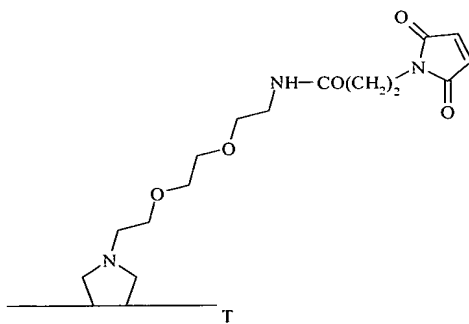
32. (new) A functionalized carbon nanotube according to claim 31, wherein $a=b=0$ and Y is a reactive group selected from the list comprising $-\text{OH}$, $-\text{NH}_2$, $-\text{COOH}$, $-\text{SH}$, $-\text{CHO}$, a ketone, such as $-\text{COCH}_3$, an azide, or a halide, in particular $-\text{NH}_2$, said functionalized carbon nanotube being, if appropriate, substituted by a capping or a protecting group, in particular a Boc or acetyl group, and being for instance a functionalized carbon nanotube of one of the following formulae:



33. (new) A functionalized carbon nanotube according to claim 31, wherein $a=1$ and $b=0$, Y is derived from a reactive group and selected from the list comprising $-O-$, $-NH-$, $-COO-$, $-S-$, $-CH=$, $-CH_2-$, $-CC_kH_{2k+1}=$, wherein k is an integer from 1 to 10, in particular $-CCH_3=$, or $-CHC_kH_{2k+1}-$, wherein k is an integer from 1 to 10, in particular $-CHCH_3-$, and Z represents in particular the group of the following formula:

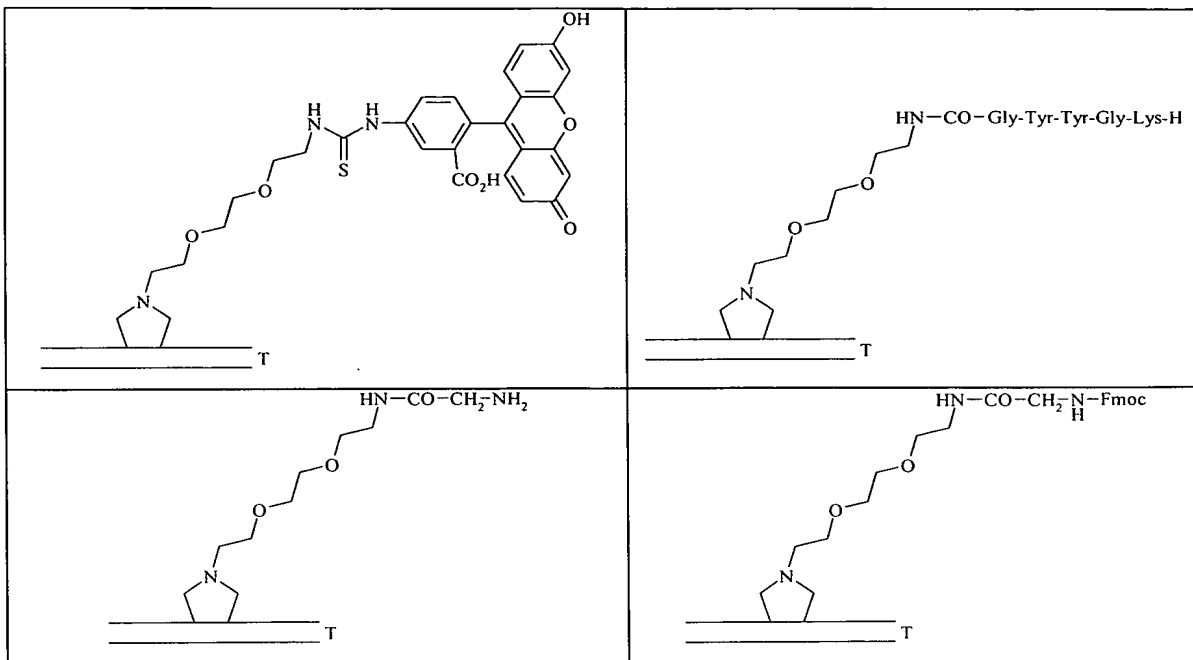


wherein q is an integer from 1 to 10, said functionalized carbon nanotube being if appropriate substituted by a protecting group being for instance the functionalized carbon nanotube of the following formula:

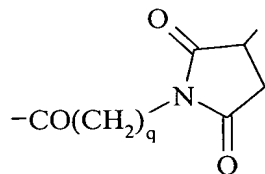


34. (new) A functionalized carbon nanotube according to claim 31, wherein $a=0$ and $b=1$, Y is derived from a reactive group and selected from the list comprising $-O-$, $-NH-$, $-COO-$, $-S-$, $-CH=$, $-CH_2-$, $-CC_kH_{2k+1}=$, wherein k is an integer from 1 to 10, in particular $-CCH_3=$, or $-CHC_kH_{2k+1}-$, wherein k is an integer from 1 to 10, in particular $-CHCH_3-$, and P is an effective group or an active molecule, in particular FITC, an amino acid, such as glycine, or a peptide, such as the peptide H-Lys-Gly-Tyr-Tyr-Gly-OH, said functionalized carbon nanotube being if appropriate substituted by a protecting group, such

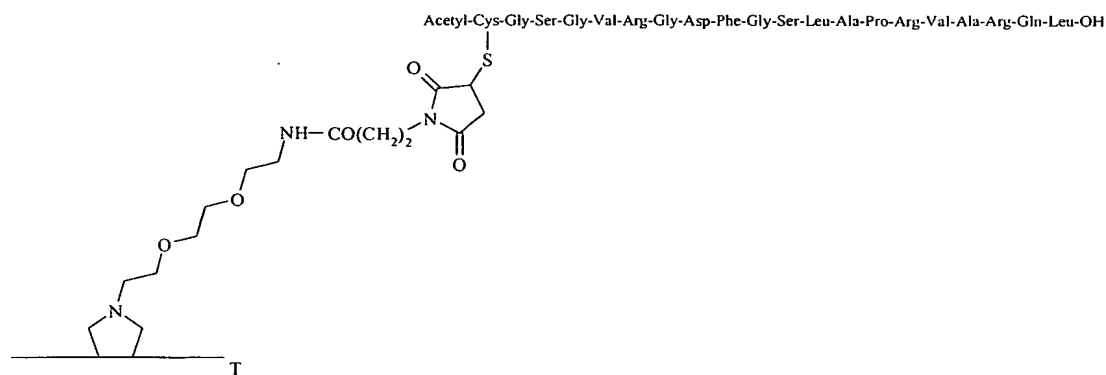
as Fmoc, and being for instance a functionalized carbon nanotube of one of the following formulae:



35. (new) A functionalized carbon nanotube according to claim 31, wherein $a=1$ and $b=1$, Y is derived from a reactive group and selected from the list comprising $-O-$, $-NH-$, $-COO-$, $-S-$, $-CH=$, $-CH_2-$, $-CC_kH_{2k+1}=$, wherein k is an integer from 1 to 10, in particular $-CCH_3=$, or $-CHC_kH_{2k+1}-$, wherein k is an integer from 1 to 10, in particular $-CHCH_3-$, Z represents in particular the group of the following formula:

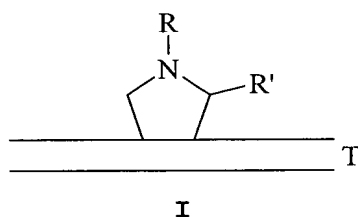


wherein q is an integer from 1 to 10, and P is a peptide, such as the peptide Acetyl-Cys-Gly-Ser-Gly-Val-Arg-Gly-Asp-Phe-Gly-Ser-Leu-Ala-Pro-Arg-Val-Ala-Arg-Gln-Leu-OH, said functionalized carbon nanotube being if appropriate substituted by a protecting group, being for instance the functionalized carbon nanotube of the following formula:



36. (new) A functionalized carbon nanotube according to claim 34, wherein P is a peptide or a protein, said peptide or protein comprising in particular a B cell epitope or a T cell epitope, such as a T helper epitope or a T cytotoxic epitope, or a mixture thereof.

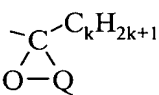
37. (new) A process for preparing a functionalized carbon nanotube of the following formula I:

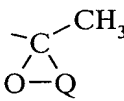


wherein T represents a carbon nanotube and independently from each other R and R' represent -H or a group of formula -M-Y, provided R and R' cannot simultaneously represent H, wherein:

- -M- is a spacer group from about 1 to about 100 atoms, such as a group selected from the list comprising - $(\text{CH}_2)_r$ - or $-(\text{CH}_2-\text{CH}_2-\text{O})_r-\text{CH}_2-\text{CH}_2-$, wherein r is an integer from 1 to 20;
- -Y is a reactive group, such as a group selected from the list comprising, -OH, -NH₂, -COOH, -SH, -CHO, a ketone such as -COCH₃, an azide, a halide, if

appropriate protected, such as -O-Q, -NH-Q, -COO-Q, -

S-Q, -CH(OQ)₂,  wherein k is an integer from

1 to 10, in particular , wherein Q is a protecting group or forms a protecting group with the adjacent atoms to which it is linked;

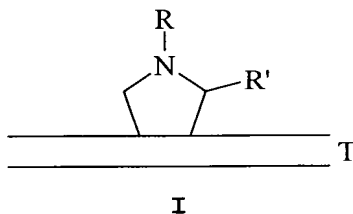
said process comprising the following step:

- adding, to a carbon nanotube, the compounds R'-CHO and R-NH-CHR''-COOR''' by a 1,3-dipolar cycloaddition, wherein:
 - R and R' are as defined above;
 - R'' is -H or an amino acid side-chain;
 - R''' is -H, an alkyl group of 1 to 5 carbon atoms, a (CH₂CH₂O)_t-CH₃ group, wherein t is an integer from 1 to 20, or an aromatic group;

to obtain a functionalized carbon nanotube of formula I, if appropriate protected;

- if necessary, deprotecting the functionalized carbon nanotube of formula I, to obtain an unprotected functionalized carbon nanotube of formula I.

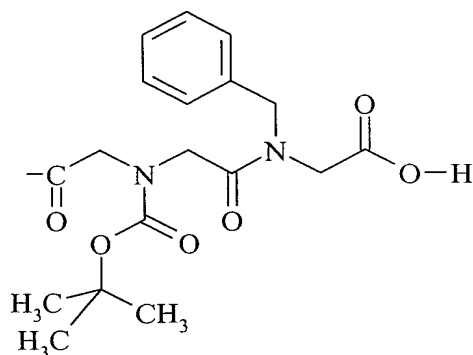
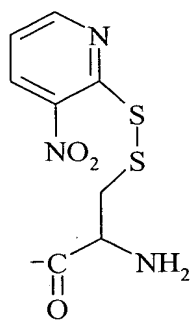
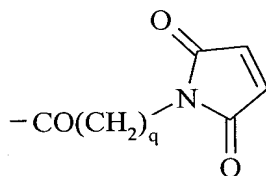
38. (new) A process for preparing a functionalized carbon nanotube of the following formula I:

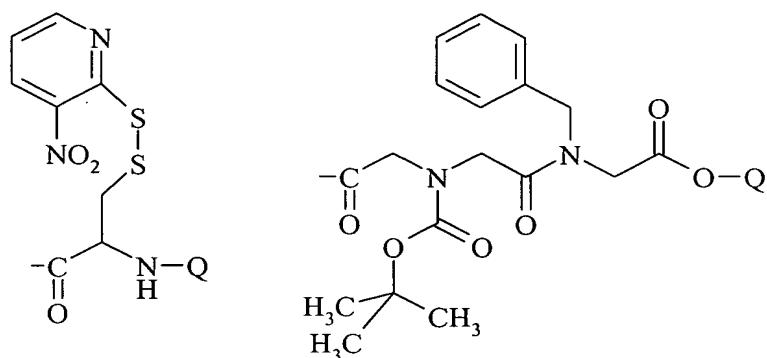


wherein T represents a carbon nanotube and independently from each other R and R' represent -H or a group of formula

-M-Y-Z, provided R and R' cannot simultaneously represent -H, wherein:

- -M- is a spacer group from about 1 to about 100 atoms, such as a group selected from the list comprising $-(CH_2)_r-$ or $-(CH_2-CH_2-O)_r-CH_2-CH_2-$, wherein r is an integer from 1 to 20;
- -Y- is a group derived from a reactive group, such as a group selected from the list comprising, -O-, -NH-, -COO-, -S-, -CH=, -CH₂-, -CC_kH_{2k+1}=, wherein k is an integer from 1 to 10, in particular -CCH₃=, or -CHC_kH_{2k+1}-, wherein k is an integer from 1 to 10, in particular -CHCH₃-;
- -Z is a linker group, liable to be linked to a P group, and if need be to release said P group, if appropriate protected by a capping or a protecting group -Q, such as a group of one of the following formulae:

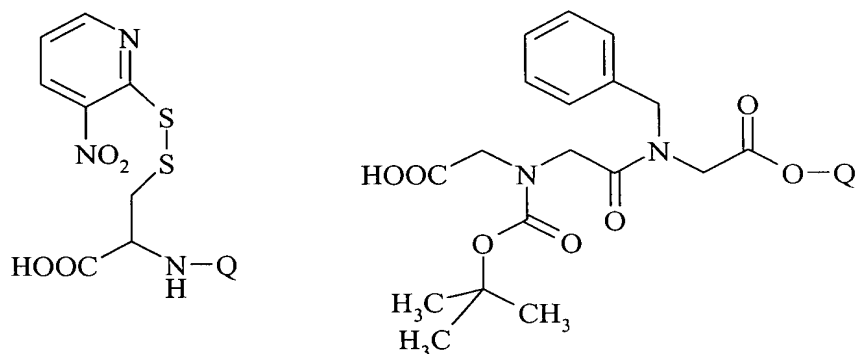
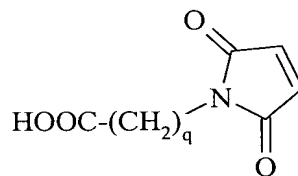




wherein q is an integer from 1 to 10;

said process comprising the following steps:

- adding to a unprotected functionalized carbon nanotube of formula I according to claim 37 a linker group of formula Z, if appropriate protected by a capping or a protecting group -Q , such as a group of one of the following formulae:

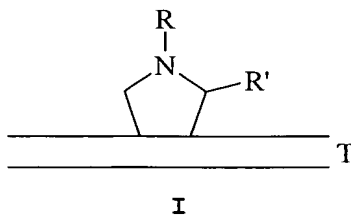


wherein q is an integer from 1 to 10;

to obtain a functionalized carbon nanotube of formula I, if appropriate protected;

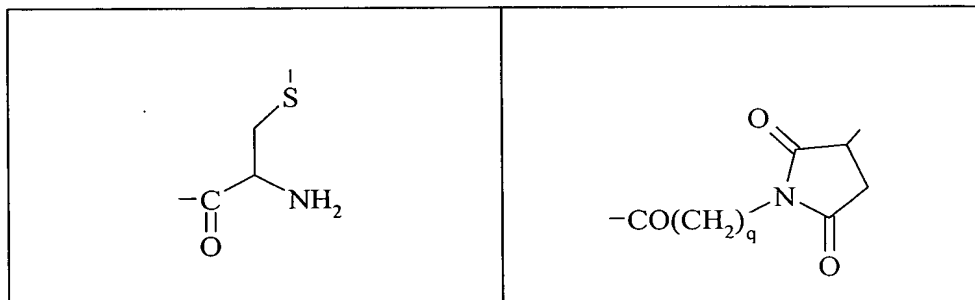
- if necessary, deprotecting the functionalized carbon nanotube of formula I, to obtain an unprotected functionalized carbon nanotube of formula I.

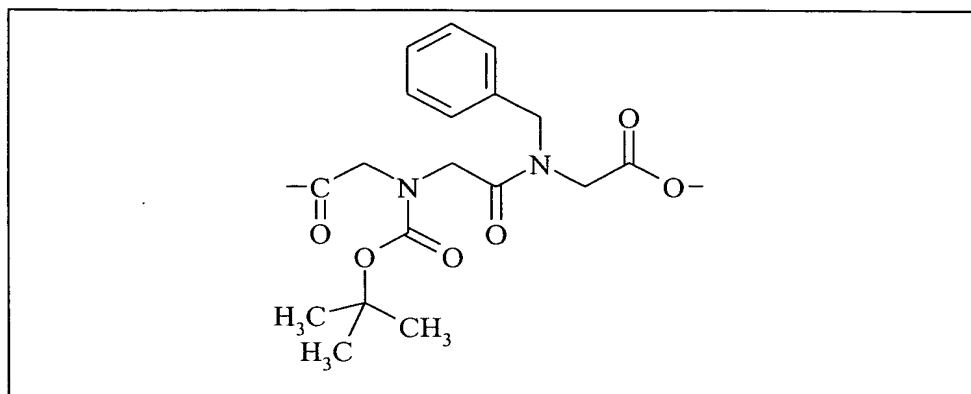
39. (new) A process for preparing a functionalized nanotube of the following formula I:



wherein T represents a carbon nanotube and independently from each other R and R' represent -H or a group of formula -M-Y-Z-P or of formula -M-Y-P, provided R and R' cannot simultaneously represent -H, wherein:

- -M- is a spacer group from about 1 to about 100 atoms, such as a group selected from the list comprising - $(\text{CH}_2)_r$ - or - $(\text{CH}_2\text{-CH}_2\text{-O})_r\text{-CH}_2\text{-CH}_2\text{-}$, wherein r is an integer from 1 to 20;
- -Y- is a group derived from a reactive group, such as a group selected from the list comprising, -O-, -NH-, -COO-, -S-, -CH=, -CH₂-, -CC_kH_{2k+1}=, wherein k is an integer from 1 to 10, in particular -CCH₃=, or -CHC_kH_{2k+1}-, wherein k is an integer from 1 to 10, in particular -CHCH₃-;
- -Z- is a linker group, liable to be linked to a P group, and if need be to release said P group, such as a group of one of the following formulae:

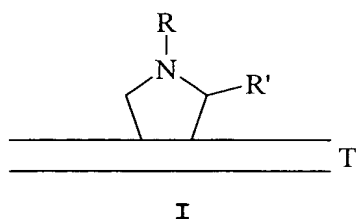




wherein q is an integer from 1 to 10;

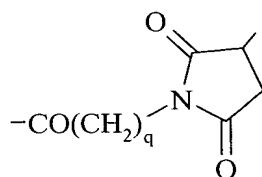
- -P is an effective group allowing spectroscopic detection of said functionalized carbon nanotube, such as a fluorophore, such as FITC, or an active molecule, liable to induce a biological effect, if appropriate protected, such as an amino acid, a peptide, a pseudopeptide, a protein, such as an enzyme or an antibody, a nucleic acid, a carbohydrate, or a drug;
- said process comprising the following steps:
- adding to an unprotected functionalized carbon nanotube of formula I according to claim 37, an effective group or an active molecule of formula P, if appropriate protected, such as a fluorophore, such as FITC, an amino acid, a peptide, a pseudopeptide, a protein, such as an enzyme or an antibody, a nucleic acid, a carbohydrate, or a drug,
 - or adding to an unprotected functionalized carbon nanotube of formula I, a group of formula Z-P, if appropriate protected,
 - to obtain a functionalized carbon nanotube of formula I, if appropriate protected;
 - if necessary, deprotecting the functionalized carbon nanotube of formula I, to obtain an unprotected functionalized carbon nanotube of formula I.

40. (new) A process for preparing a peptide or protein functionalized carbon nanotube, of the following formula I:



wherein T represents a carbon nanotube and independently from each other R and R' represent H or a group of formula -M-Y-P, or of formula -M-Y-Z, provided R and R' cannot simultaneously represent -H, wherein:

- -M- is a spacer group from about 1 to about 100 atoms, such as a group selected from the list comprising $-(CH_2)_r-$ or $-(CH_2-CH_2-O)_r-CH_2-CH_2-$, wherein r is an integer from 1 to 20;
- -Y- is a group derived from a reactive group, such as a group selected from the list comprising, -O-, -NH-, -COO-, -S-, -CH=, -CH₂-, -CC_kH_{2k+1}=, wherein n is an integer from 1 to 10, in particular -CCH₃=, or -CHC_kH_{2k+1}-, wherein k is an integer from 1 to 10, in particular -CHCH₃-;
- -Z- is a linker group, in particular a group of the following formula:

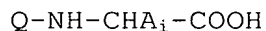


wherein q is an integer from 1 to 10;

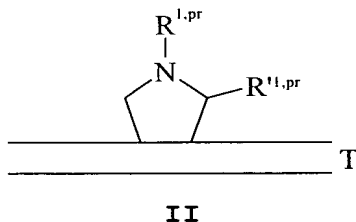
- -P is a peptide, in particular of following formula: $-[OC-CH(A_i)-NH]_t-H$, wherein -A_i is an amino acid side-chain, i is an integer from 1 to t and t is an integer from 1 to 150, advantageously from 1 to 50;

said process comprising the following steps:

- adding to a functionalized carbon nanotube of formula I, according to claim 37, a protected amino acid of the following formula:

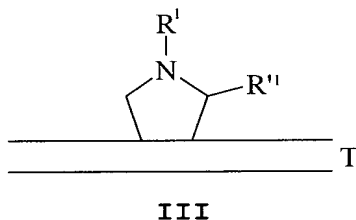


wherein $-A_i$ is as defined above and $-Q$ is a protecting group to obtain a functionalized carbon nanotube of the following formula II:



wherein independently from each other $R^{1,pr}$ and $R'^{1,pr}$ represent $-H$ or a group of formula $-M-Y-OC-CH_{A_i}-NH-Q$, or of formula $-M-Y-Z-OC-CH_{A_i}-NH-Q$, wherein $-M-$, $-Y-$, $-Z-$, $-A_i$ and $-Q$ are as defined above;

- deprotecting the functionalized carbon nanotube of formula II to obtain a functionalized carbon nanotube of the following formula III:

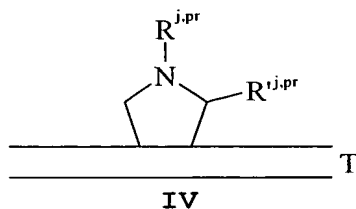


wherein independently from each other R^1 and R'' represent $-H$ or a group of formula $-M-Y-OC-CH_{A_i}-NH_2$, or of formula $-M-Y-Z-OC-CH_{A_i}-NH_2$, wherein $-M-$, $-Y-$, $-Z-$, and $-A_i$ are as defined above;

- adding to the functionalized carbon nanotube obtained at the preceding step a protected amino acid of the following formula:

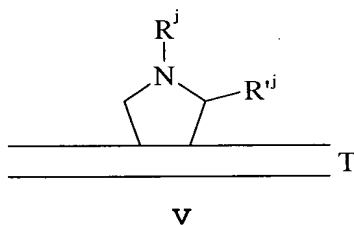


wherein $-A_i$ is as defined above and $-Q$ is a protecting group to obtain a functionalized carbon nanotube of the following formula IV:



wherein independently from each other $R^{j,pr}$ and $R^{i,j,pr}$ represent $-H$ or a group of formula $-M-Y-[OC-CHA_i-NH]_j-Q$, or of formula $-M-Y-Z-[OC-CHA_i-NH]_j-Q$, wherein $-M-$, $-Y-$, $-Z-$, $-A_i$ and $-Q$ are as defined above, and j is an integer from 2 to t ;

- deprotecting the functionalized carbon nanotube of formula IV to obtain a functionalized carbon nanotube of the following formula V:



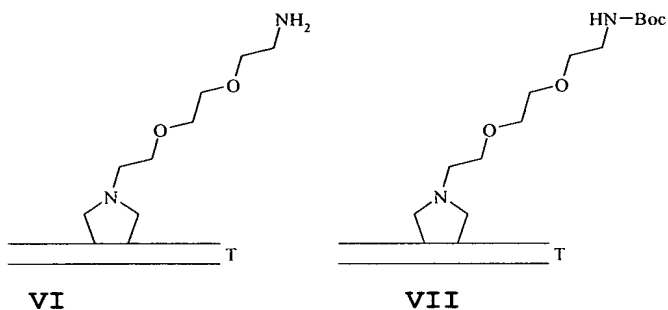
wherein independently from each other R^j and R^{ij} represent $-H$ or a group of formula $-M-Y-[OC-CHA_i-NH]_j-H$, or of formula $M-Y-Z-[OC-CHA_i-NH]_j-H$, wherein $-M-$, $-Y-$, $-Z-$, and $-A_i$ are as defined above, and j is an integer from 2 to t ;

- repeating the last two steps $t-1$ times to obtain a peptide or protein functionalized carbon nanotube of formula I.

41. (new) A process according to claim 38, wherein $-Q$ is a capping group, such as CH_3CO- (acetyl), methyl, or ethyl, or a protecting group, such as a group selected from the list comprising methyl, ethyl, benzyl, *tert*-butyl, trityl, 3-nitro-

2-pyridylsulfenyl, *tert*-butyloxycarbonyl (Boc),
 fluorenylmethyloxycarbonyl (Fmoc), benzylcarbonyl,
 trimethylsilylethyloxycarbonyl, phthalimide, or ethyleneoxy.

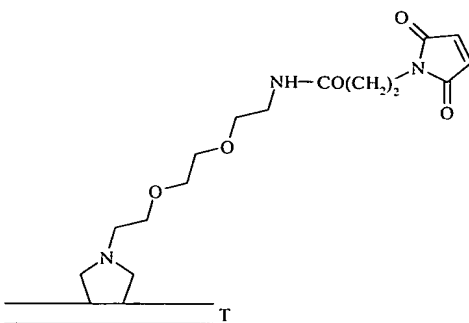
42. (new) A process for preparing a functionalized carbon nanotube of one of the following formulae VI and VII:



wherein T represents a carbon nanotube and Boc represents *tert*-butyloxycarbonyl, said process comprising the following steps:

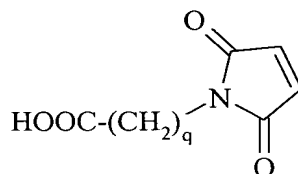
- adding, to a carbon nanotube, the compounds $(\text{CH}_2\text{O})_n$ (*para*formaldehyde) and $\text{Boc-NH}-(\text{CH}_2-\text{CH}_2-\text{O})_2-\text{CH}_2-\text{CH}_2-\text{NH}-\text{CH}_2-\text{COOH}$ by a 1,3-dipolar cycloaddition, to obtain a protected functionalized carbon nanotube of formula VII;
- if necessary, deprotecting the protected functionalized carbon nanotube of formula VII, to obtain an unprotected functionalized carbon nanotube of formula VI.

43. (new) A process for preparing a functionalized carbon nanotube of the following formula VIII:

**VIII**

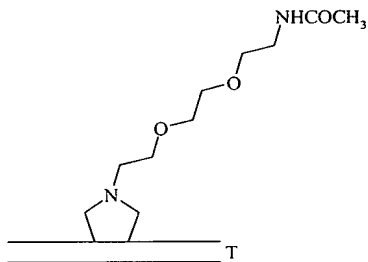
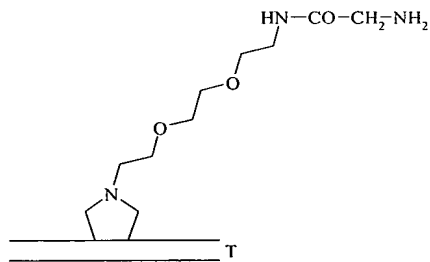
wherein T represents a carbon nanotube, said process comprising the following step:

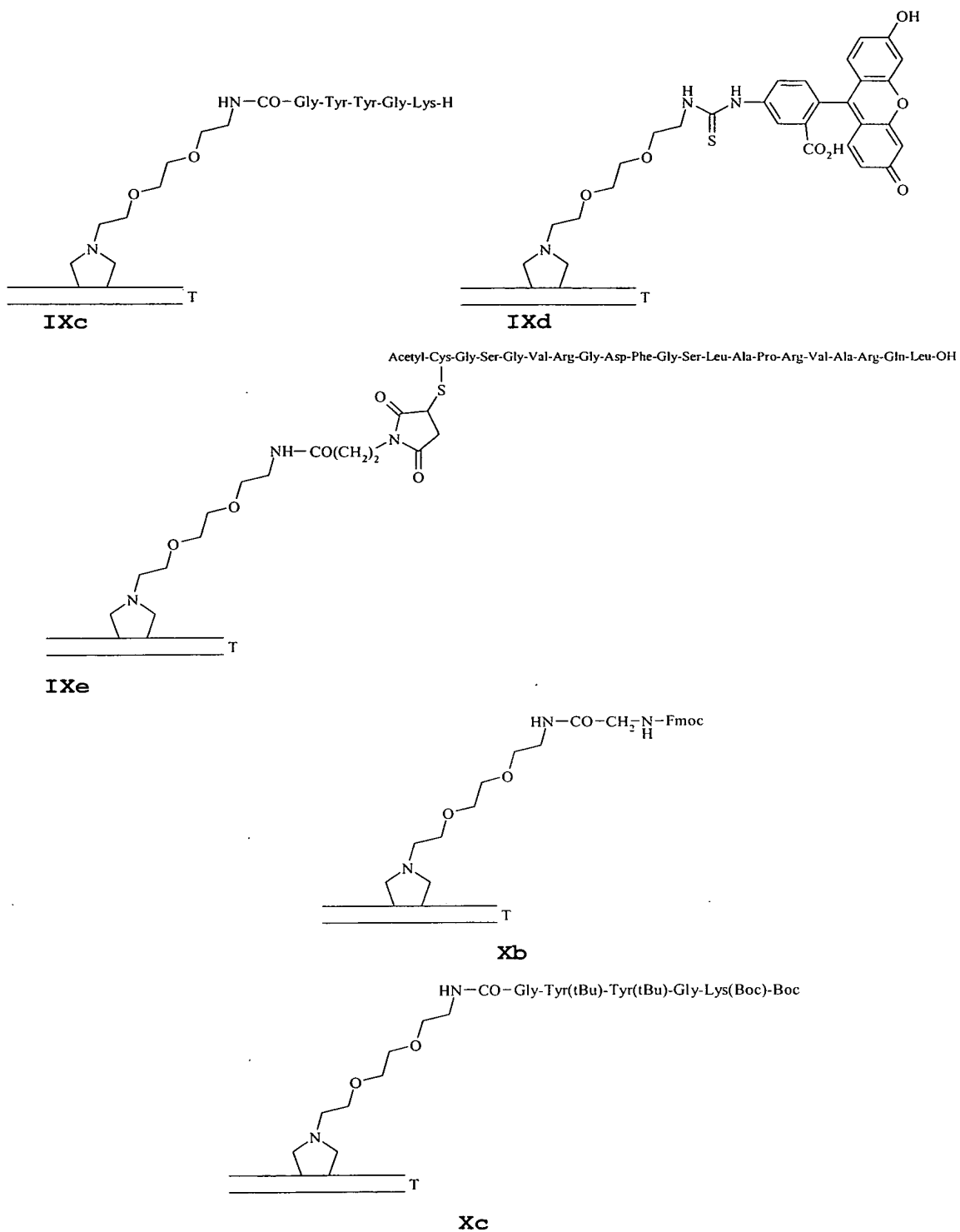
- adding, to a carbon nanotube of formula VI according to claim 42, a compound of the following formula:



to obtain a functionalized carbon nanotube of formula VIII.

44. (new) A process for preparing a functionalized carbon nanotube of one of the following formulae IXa, IXb, IXc, IXd, IXe, Xb and Xc:

**IXa****IXb**



wherein T represents a carbon nanotube, Fmoc represents fluorenylmethyloxycarbonyl, tBu represents tert-butyl and

Boc represents tert-butyloxycarbonyl, said process comprising the following steps:

- adding,
 - either to a functionalized carbon nanotube of formula VI according to claim 42, a group chosen among: $\text{CH}_3\text{-COOH}$, Fmoc-Gly-OH, Boc-Lys(Boc)-Gly-Tyr(tBu)-Tyr(tBu)-Gly-OH, or FITC,
 - or to a functionalized carbon nanotube of formula VIII, the following group, Acetyl-Cys-Gly-Ser-Gly-Val-Arg-Gly-Asp-Phe-Gly-Ser-Leu-Ala-Pro-Arg-Val-Ala-Arg-Gln-Leu-OH,to obtain a functionalized carbon nanotube of respective formula IXa, Xb, Xc, IXd or IXe;
- if necessary, deprotecting the functionalized carbon nanotube of formula Xb or Xc to obtain respectively the functionalized carbon nanotube of formula IXb or IXc.

45. (new) A functionalized carbon nanotube such as obtained by the process of claim 37.

46. (new) A pharmaceutical composition comprising as active substance at least one functionalized carbon nanotube according to claim 27, in association with a pharmaceutically acceptable vehicle, such as a liposome, a cyclodextrin, a microparticle, a nanoparticle, or a cell penetrating peptide.

47. (new) A method of transport of pharmaceutically active molecules comprising the use of a functionalized carbon nanotube according to claim 27.

48. (new) A method of delivery of drugs, in particular of intracellular delivery of drugs, comprising the use of an

appropriate amount of a functionalized carbon nanotube according to claim 27.

49. (new) A method of preparation of an immunogenic composition intended to provide an immunological protection to the individual to whom it has been administered, comprising the use of an appropriate amount of a functionalized carbon nanotube according to claim 27.

50. (new) A method for the treatment or the prophylaxis of cancer, autoimmune or infectious diseases, comprising the administration of an appropriate amount of a functionalized carbon nanotube according to claim 27.

51. (new) A method of preparation of functionalized surfaces such as plastic or glass surfaces comprising the use of a functionalized carbon nanotube according to claim 27.

52. (new) A method of preparation of electrochemical biosensors comprising the use of a functionalized carbon nanotube according to claim 27.